Australian Journal of Basic and Applied Sciences, 9(5) March 2015, Pages: 21-30

ISSN:1991-8178

Australian Journal of Basic and Applied Sciences

Journal home page: www.ajbasweb.com

PSAA: A Novel Procedure for Satellite Imagery Processing based on Grid Environment

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ARTICLE INFO

Article history:
Received 12 November 2014
Received in revised form 26 December 2014
Accepted 29 January 2015
Available online 10 February 2015

Keywords:
Grid computing, Satellite imagery processing, Globus grid, Pheromone scheduling assessment algorithm (PSAA), Job or Resource scheduling, Grid information server (GIS), Resource broker.

ABSTRACT

Background: PSAA: A Novel Procedure for Satellite Imagery Processing based on Grid Environment.**Objective:** Grid Computing refers to the emerging computer and networking infrastructure. An open source Globus-4.0.5 toolkit offers middleware services for the grid environment. Satellite imagery processing is accomplished by grid environment. In the proposed work, satellite imagery is processed to accurate the defects such as haze, cloud and sensor induced defects. Here, the user jobs are scheduled in grid environment to achieve the highest possible system throughput. Job scheduling is the mapping of jobs to specific physical resources and to effectively acquire the parallel execution of user jobs. A key is contributed to each user in a grid environment, to enforce authentication process. The proxy certificate is authorized only for authenticated user and the requested jobs is accredited to the Grid Information Server (GIS). GIS sustains the working status, success-rate and false-rate of each machine in grid environment. Depends on enumerating the value of success and false-rate, an innovative Pheromone Scheduling Assessment Algorithm (PSAA) is decapitated by a GIS. Lastly, GIS can also uphold the available resource of all machines in a virtual grid environment by resource broker. The experimental outcomes depict better performance than the existing Dynamic Load Balancing Technique (DLBT) in terms of computation time, cost-complexity and the failure-status. **Results:**The results and a discussion of the proposed methodology by comparing with the existing dynamic load balancing technique (DLBT). The user jobs are scheduled and the creation of grid environment is processed using Globus Grid 4.0.5 toolkit. In high performance computing, the necessity for effective DLBT can be maxim to solve the difficulties such as (a) unscalable, (b) application specific, and (c) complexity. **Conclusion:** In this work, a novel Pheromone Scheduling Assessment Algorithm (PSAA) is proposed. The user job scheduling is playing a major role to minimize the cost function specified by the user. Certain key is produced to each user in grid environment for performing authentication process. The proxy certificate is generated only for authenticated user and the requested jobs is assigned to the GIS. GIS maintains the working status, success rate and failure rate for each machine. Finally, GIS can also maintain the available resource of all machines in a virtual grid environment by resource broker. The experimental results show better performance than the existing Dynamic Load Balancing Technique (DLBT) in terms of cost and time complexity, system throughput, level of accuracy, and also the status of the failure. In future work, the fault tolerance will integrate with this proposed system that increase in response time.

To Cite This Article: Devabalan P and Dr. Saravanan R., PSAA: A Novel Procedure for Satellite Imagery Processing based on Grid Environment. ***Aust. J. Basic & Appl. Sci.,*** *9(5): 21-30, 2015*

INTRODUCTION

Grid computing is a method of distributed computingwhich allows allocation and related use of various resources from multiple location to attain a common goal. It is dynamic, more loosely coupled computers, heterogeneous, geographically dispersed virtual organizations. Computer resources types arecomputation, storage, communications, software and licenses and more. These resources are not centrally managed. Fig.1 shows a basic structure of grid computing.Using the grid, many large-scale computational demands are solved, which cannot be

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determined by a single computer.The benefits of grid computing are as follows:

- Easier to collaborate with other organizations
- Make better use of existing hardware
- Exploiting under utilized resources
- Parallel CPU capacity
- Access to additional resources
- Resource balancing
- Reliability

Grid services allow the scientistsat various locations throughout the world to share the data collection instruments. It includes particle colliders, supercomputers, clusters of workstations, and community dataset. The Globus Grid toolkit is developed in the Globus project that provides the middleware services for grid environments. Its major component is Grid Security Infrastructure (GSI) which provides public-key based authentication and authorization services. It also allows retrieval of information about grid resources.

Satellite imagery includes photographs of the earth taken through an artificial satellite revolving around the earth. The process of correcting these satellite images for haze, cloud and sensor induced defects within satellite image and overlaying the 2D satellite image on 3D surface of the earth is called satellite image processing. Processed satellite images have different scientific and need based applications in the field of agriculture, geology, forestry, biodiversity conservation, regional planning, education, intelligence and warfare.

In the proposed work, the user jobs are scheduled in grid environment to attain the highest possible system throughput. A key is provided to each user in grid environment to perform authentication process. The proxy certificate is generated only for authenticated user and the requested jobs is assigned to the grid information server (GIS).

Fig. 1: A Basic Structure of Grid Computing.

GIS maintains the working status, success-rate and false-rate of each machine in grid environment. Depends on counting the value of success andfalse-rate, a novel Pheromone Scheduling Assessment Algorithm (PSAA) is performed by a GIS. Finally, GIS can also maintain the available resource of all machines in a virtual grid environment by resource broker.The proposed algorithm is not enhanced using the Globus toolkit,it is employed only for the grid environment creation and configuration procedure. The Globus toolkit can be able to distribute the certificate for all the hosts. Furthermore, it also used to create the secure grid environment for executing the jobs .

The rest of the paper is systematized as follows. Section II briefly overview the related works in the satellite image processing and job scheduling techniques. Section III involves the detailed explanation about the proposed method. Section IV describes the implementation details. Section V summarizes with a brief conclusive remark and discussion on future works.

Relevant Literature Work:

This section deals with the related work based on satellite image processing in grid environment. *Mihon et al*described the architecture of the environment oriented satellite data processing platform (ESIP) and the basic toolset of gProcess. It also focussed the satellite imagery processing methodology in the domain of earth observation (EO). It was helpful for increasing the accuracy of the method by preventing and recovering an error(Mihon 2011).*Dana et al*described a service oriented platform which satisfies the requirements for both user and system in the field of earth observations (EO) systems. A custom query language was proposed to query external services. It provides faster response to the requirements using EO systems and the distributed platform(Dana *et al*. 2010).

Arias et al introduced self organizing map (SOM) algorithm. The training time was considerably decreased while related to the local solution with a grid infrastructure. For classification phase, the minimal error map was chosen using grid parallelization. It ensures security and provides better results with a grid solution (Arias *et al*. 2009).The authors in (Shepherd, Passmore, and Kamal 2010) also presented a SOM neural network modelwhich integrated witha geographical information system (GIS) layers. The SOM_PAKsoftware was introduced and used for the SOM classification. It was incapable to gather the images and data of GIS. It increases the flexibility of the classification.*Hsu et al*developed a novel job scheduling methodology. It was applicable to a broader class of communicating applications on large heterogeneous systems.It attains perfect data locality, minimizes the overhead of I/O and also decreased the scheduling cost(Hsu *et al*. 2012).

*Manimala et al*enhanced hierarchical load balance algorithm. It was designedfor job scheduling that allocate resources to tasks. It increased the throughput of the system and minimize the job completion time. It also minimizes the makespan of the executed jobs(Manimala and Suresh 2013).*Gorgan et al* presented the grid oriented GiSHEO eLearning environment (eGLE). The environment of eGLE is based on the platform of the gProcess. It supportedthe research and analysis in earth observation. It was also useful for development and execution process of teaching material (Gorgan, Stefanut, and Bacu 2009).*Giuliani et al*introduced the spatial data infrastructure (SDI) using Open Geospatial Consortium (OGC) web services.It offers an interoperable framework for retrieving geospatial data. Also construct new functions to attain a precise task established on reusable services (Giuliani, Ray, and Lehmann 2011).

Ostberg et al proposed Service-Oriented Architecture (SOA) for managing grid job. The infrastructure was designed for federated grid environments to decouple grid applications after grid middleware(Östberg and Elmroth 2013).*Enoiu et al*presented an environment for service-oriented systems which enable graphical model for service based textual systems. It provides an automated traceability which enhances the system potential(Enoiu *et al*. 2013).*Dube et al*discussed the overview of the Grid Services for Earth Observation Image Data Processing (GEOID) architecture.It provides requirements for processingapplications with respect to time series, and quality(Dube, Ramakrishnan, and Dasgupta 2013).

*Izakian et al*introduced a continuous double action (CDA) methodology for allocating grid resource. Entities in this method were permitted to access in grid environment and also useful for decision making(Izakian, Abraham, and Ladani 2010).*Srivastava et al*proposed numerous concepts for load balancing that solve high demanding applications. It attains better performance and efficiency of the system(Srivastava, Gupta, and Yadav 2011).*Alexanin et al* developed the network infrastructure for grid services. It increases the speediness of data processing and also produce possible time period. The performance analysis of this method provides high performance over external computing resources(Alexanin *et al*. 2011).*Lee et al* introduced a novel Hierarchial Load Balanced Algorithm (HLBA) for grid computing environment. It is composed of a hierarchical framework and a user job scheduling algorithm. It decreases the makespan of user jobs and system load was also balanced(Lee, Leu, and Chang 2011).

*Giuliani et al*presented the mediation concept to improve the usability of web processing service (WPS). It provides better performance and scalability(Giuliani *et al*. 2012).*Pooranian et al*proposed a hybrid scheduling algorithmcombined with particle swarm optimization with the gravitational emulation local search (PSO-GELS). It explained the independent task scheduling problem in a grid computing environment(Pooranian, Shojafar, Abawajy, *et al*. 2013).*Pooranian et al* introduced a novel hybrid scheduling algorithm. It was a combination of GELS and the genetic algorithm (GA). It provides optimal computation time(Pooranian, Shojafar, Tavoli, *et al*. 2013).*Prakash et al*proposed a new technique for the problem of grid scheduling. It is useful for maximizing the availability. The problems were solved by using GA along with a metaheuristic algorithm. It was based on evolutionary computation to compute the complex problems(Prakash and Vidyarthi 2014).*Babu et al* described a scheduling technique using GA. It was used to schedule the user jobs in a grid computing environment effectively. It improves the overall performance for various sizes of the job requisition(Babu and Amudha 2014).

Globus Grid Toolkit - 4.0.5 (Gt4)

The key properties of proposed approach based on Globus toolkit are:

- Creating the grid working environment.
- Providing certificate for each host in the grid environment using X509 certification, which is one of theproperty of the globus toolkit.
- Providing user certificate for security purpose.

The grid is associate infrastructure that involves the integrated and cooperative use of computers, networks, databases and scientific instruments. These infrastructures are managed by multiple organizations. Many software package toolkits and systems are developed.Globus Grid-4.0.5 toolkit (GT4) is an open source toolkit that provides the middleware services for grid computing environment.

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Globus Toolkit 4.0.5 (Gt4) Components

GT4 focusses on web services and is composed of several components as shown in the Fig. 2, these components are divided into following categories:

- GSI security layer
- Grid data management
- Grid resource management
- Grid information services

Gsi Security Layer:

The Grid Security Infrastructure (GSI) provides strategies for authentication of grid users and secure communication. It supports SSL (Secure Sockets Layer), PKI (Public Key Infrastructure) and X.509 certificate architecture. The GSI provides services and protocols associate in libraries to realize the subsequent aims for grid security:

- Single sign-on for mistreatment grid services through user certificates
- Resource authentication through host certificates
- Knowledge encryption
- Authentication authorization
- Delegation of authority and trust through proxies and certificate.

Grid Data Management:

The knowledge management package provides utilities and libraries for transmittal, storing and managing huge datasets of many scientific computing applications in virtual organizations.

Grid File Transfer Protocol (Ftp):

It is associate in extension of the customary FTP protocol that provides secure, economical and reliable data movements in grid environments. In addition to customary FTP functions, Grid FTP provides GSI support for authenticated knowledge transfer, third-party transfer invocation and stripes, parallel and partial knowledge transfer support.

Replica Location And Management

This part supports multiple locations for an equivalent file throughout the grid. Mistreatment the duplicate management functions, a file is often registered with the duplicate. The location Service (RLS) and its replicas are often created and deleted. Within RLS, a file is known by its Logical File Name (LFN) and is registered among a logical assortment. The record is for a file point to its physical locations. This data is available from the RLS for querying.

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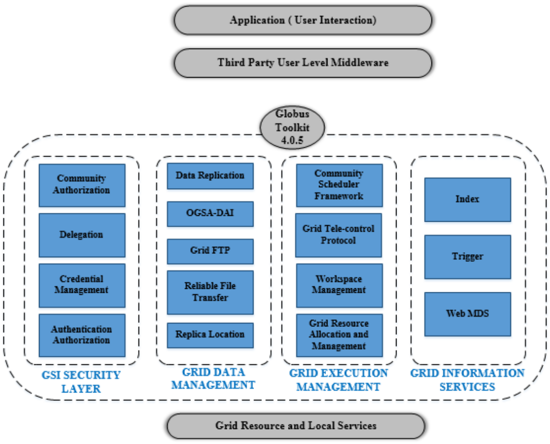

Fig. 2: Globus Grid Toolkit - 4.0.5 (GT4) Architecture.

Grid Resource Management:

The resource management package allows resource allocation through job submission, performance of feasible files,job execution and result gathering. The elements of Globus among this package are as follows:

- Community scheduler framework
- Grid tele-control protocol
- Workspace management
- Grid resource and allocation management

Globus Resource Allocation Manager (GRAM):

GRAM provides remote execution capability and reportstatus for the course of the execution. A consumer requests employment submission to the gatekeeper daemon on the remote host. The gatekeeper daemon checks if the consumer is permitted. Once authentication is over, the gatekeeper starts a job manager that initiates and monitors the work execution. Globus Resource Specification Language(RSL) providessyntax consisting of attribute-value pairs for describing resources needed for employment, including the minimum memory and therefore the variety of CPUs.

Grid Information Services:

The data services package provides static and dynamic properties of the nodes that connected to the Grid. The Globus elements among this package are:

- Web Monitoring and Discovery Service (MDS)
- Index
- Trigger

Monitoring and Discovery Service (MDS):

MDS provides support for business and querying of resource data. MDS has a three-tier structure: Information suppliers (at the bottom) that gather knowledge regarding resource properties and translate them into the format defined by the article categories.

Satellite imagery processing based on grid environment:

The difference between the proposed workflow and the ordinary workflow for the satellite image processing is described as follows:

- The selection of grid node for the satellite image processing in ordinary workflows either follows available grid node or load free grid node.
- It wont ensure whether the grid node can have a capability to complete the task, because the existing scheduling approaches are generally unaware of the grid node characteristics.
- In the proposed approach, a novel scheduling system that consider the grid node properties as well as success ratio of the grid node is introduced. The trusted environment based scheduling approaches are also implemented to ensure that whether the job submitted by a valid user or not. This process will avoid the unwanted job execution submitted by unwanted users. Here, the secure key sharing mechanism will follows based on the GT4.0.5.

In general, the satellite images are most sensational and informative images. Therefore, the execution of satellite image processing in the trusted environment need to be concentrated. Additionally, the scheduling approaches will reduce the time taken for image processing that held in each node.The job of increasing a computational abilities of satellite imagery processing is shown in fig. 3. The GT4 permits to produce grid infrastructure and includes computing element and grid processing unit. These resources are interconnected by metropolitan area network upto 1 Gbps. Both centers have the GT4 toolkit which employs conformance certificate for the purpose of authentication and authorization.

Initially, the user jobs or resources are scheduled in grid environment. Scheduling is one of the key research areas in grid computing. Fig.4 shows the overall schema of satellite imagery processing using grid computing environment. Based on the scheduling result, the user jobs will be executed in grid environment. The main goal of scheduling is to achieve highest possible system throughput and to match the application need with the available computing resources. Job scheduling is the major role in the proposed work. It is the mapping of jobs to specific physical resources. It minimizes some of the cost function (time complexity and cost complexity) specified by the user and to effectively achieve the parallel execution of user jobs. The cost function is estimated as follows:

$$Cf = UP_{gn} * S_{gl} \quad (1)$$

Effective computation and job scheduling are rapidly becoming one of the main challenges in grid computing and is being vital for its success.

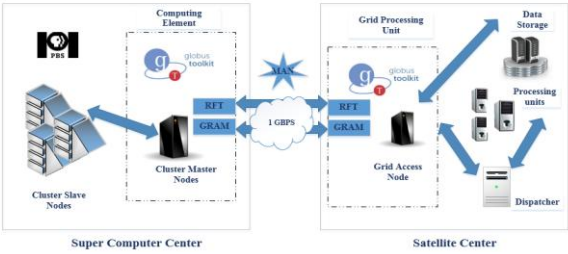

Fig. 3: Satellite imagery processing.

Before performing the scheduling process, it may need to collect the user jobs those who execute their jobs in grid environment. The Globus environment is created for running the user jobs in grid environment which provide a key to each user. Based on this key for each user, authentication process can perform. If the requested user is valid then the proxy certificate can generate for authenticated users. It will be valid for only some particular duration. After getting the proxy certificate, the requested jobs will be assigned to Grid Information Server (GIS). In GIS, it can maintain the available resource of all machines in a virtual grid environment by resource broker. Resource broker should update the available resource details of each machine in grid environment. GIS can allocate the user requested jobs to selected machines. At the same time, each machine in the grid environment should have their own resource manager. They are responsible for maintaining all the details of the particular machine.

GIS can also maintain the working status, success rate and false rate of each machine in grid environment. Based on counting the success and false rate value of each machine, GIS can perform Pheromone Scheduling Assement algorithm (PSAA). The result produced by the value of pheromone scheduling, GIS can allocate requested job to selected machine in the grid.

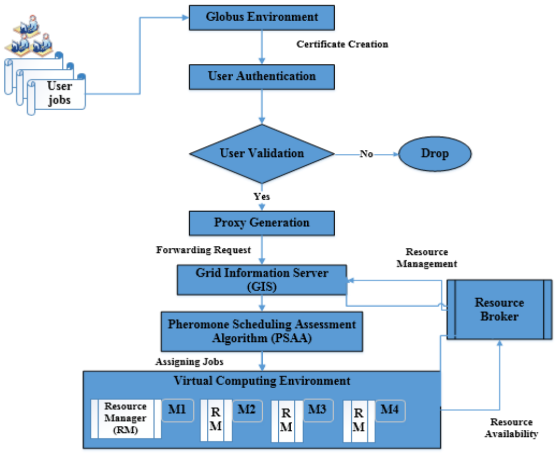

Fig. 4: The overall schema of satellite imagery processing based on grid environment.

Once the particular machine allocates or execute the job, it then starts the processing state. The machines which are in processing state can execute some other jobs by the knowledge of GIS. Using this method, the parallel processing of user jobs is achieved. It also attains time consumption and the load balancing for each resource in grid environment. If any machine suffered from an unexpected failure after allocating user jobs, it performs the reallocation process for that particular user job. It can also be performed by a GIS. After completing this

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procedure, the user jobs in grid environment have successfully submitted.

Performance Analysis:

This section presents the results and a discussion of the proposed methodology by comparing with the existing dynamic load balancing technique (DLBT). The user jobs are scheduled and the creation of grid environment is processed using Globus Grid 4.0.5 toolkit. In high performance computing, the necessity for effective DLBT can be maxim to solve the difficulties such as (a) unscalable, (b) application specific, and (c) complexity. A practical explanation of the DBLT problem includes:

- Load evaluation
- Determination of profitability
- Estimation of work transfer vector
- Selection of task
- Migration of task

In existing DBLT, the job will be splitted into many parts and also reduce the accuracy of the results. If the PSAA is applied to the satellite image processing, then the image processing accuracy will be reduced and enhanced further. Table I describes the experimental parameters used in the proposed PSAA.

Table I: Experimental parameters.

PARAMETER	VALUE
Globus Toolkit Version	4.0.5
Certificate Standard	X509
Job Size	100 to 500 MB
Number of Nodes	500
Node Speed	100 200 mbps

Time complexity:

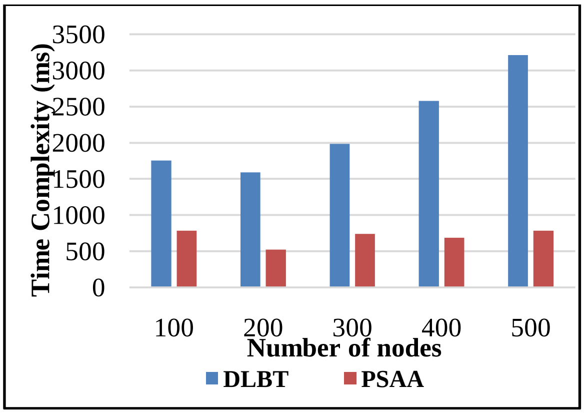

Fig. 5: The result of time complexity as to the number of nodes for DLBT (existing) and PSAA (proposed) method.

The time complexity of the proposed methodology computes the quantity of time taken by an algorithm which represents the number of nodes. Fig.5 depicts the performance analysis of time complexity with respect to the number of nodes to existing dynamic load balancing technique and the proposed pheromone scheduling assessment algorithm.

Failure Rate:

The failure rate of a system generally depends upon time with the rate fluctuating over the life series of the system. Fig.6 illustrates the analysis of failure status with respect to the number of nodes to existing dynamic load balancing technique and the proposed pheromone scheduling assessment algorithm. PSAA gives a lower failure rate than DLBT by gradually increase and decrease the values as in Fig. 6.

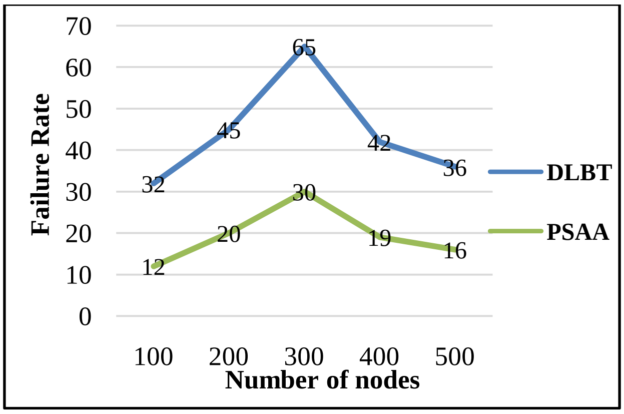

Fig. 6: The result of failure status as to the number of nodes for DLBT (existing) and PSAA (proposed) method.

Cost Complexity:

Cost complexity of the proposed methodology computes the cost taken by an algorithm which represents the number of nodes. Fig.7 describes the performance analysis of cost complexity with respect to the number of nodes for existing dynamic load balancing technique and the proposed pheromone scheduling assessment algorithm. The PSAA attains lowest cost compared to the existing method.In scheduling, the optimal load of grid nodes are chosen to minimize the cost complexity, where the existing method balance only the load.

Accuracy Level:

Accuracy is defined as the degree of proximity of calculation of a measured value and the precise or actual value. Fig.8 represents the accuracy level with respect to the number of nodes for existing dynamic load balancing technique and the proposed PSAA. The accuracy level of the proposed system is high when compared with the DLBT.

Throughput:

Throughput is the number of data transfer from one location to another location in a specified quantity of time. The data transfer rate is used for measuring the performance of disk drives and networks in relation to the throughput. Fig.9 defines the throughput of a system with respect to the number of nodes for existing DLBT and the proposed PSAA. The throughput of PSAA is greater than the DLBT as it gradually increases and decrease.

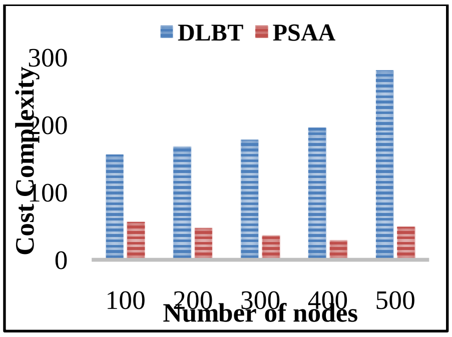

Fig. 7: The result of cost complexity as to the number of nodes for DLBT (existing) and PSAA (proposed) method.

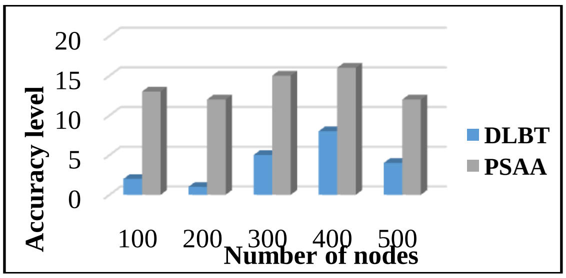

Fig. 8: The result of accuracy level as to the number of nodes for DLBT (existing) and PSAA (proposed) method.

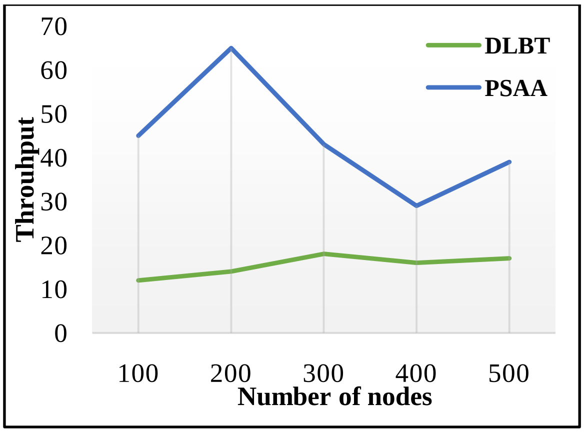

Fig. 9: The result of throughput as to the number of nodes for DLBT (existing) and PSAA (proposed) method.

Conclusion And Future Work:

In this work, a novel Pheromone Scheduling Assessment Algorithm (PSAA) is proposed. The user job scheduling is playing a major role to minimize the cost function specified by the user. Certain key is produced to each user in grid environment for performing authentication process. The proxy certificate is generated only for authenticated user and the requested jobs is assigned to the GIS. GIS maintains the working status, success rate and failure rate for each machine. Finally, GIS can also maintain the available resource of all machines in a virtual grid environment by resource broker. The experimental resultsshowbetter performance than the existing Dynamic Load Balancing Technique (DLBT) in terms of cost and time complexity, system throughput, level of accuracy, and also the status of the failure. In future work, the fault tolerance will integrate with this proposed system that increase in response time.

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